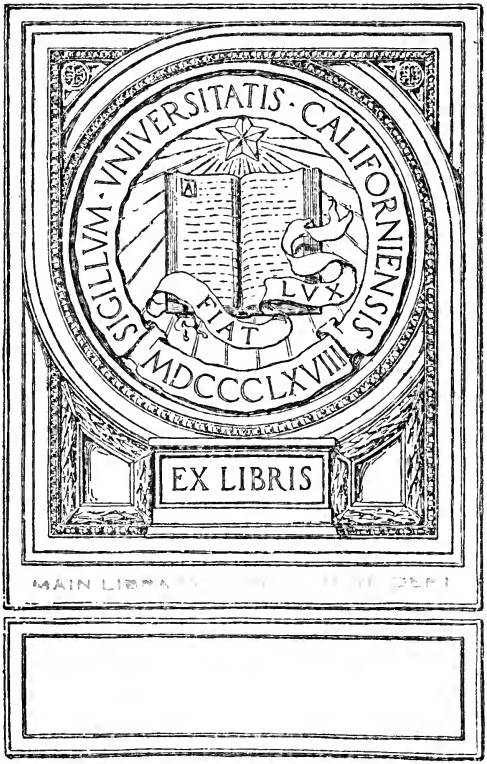

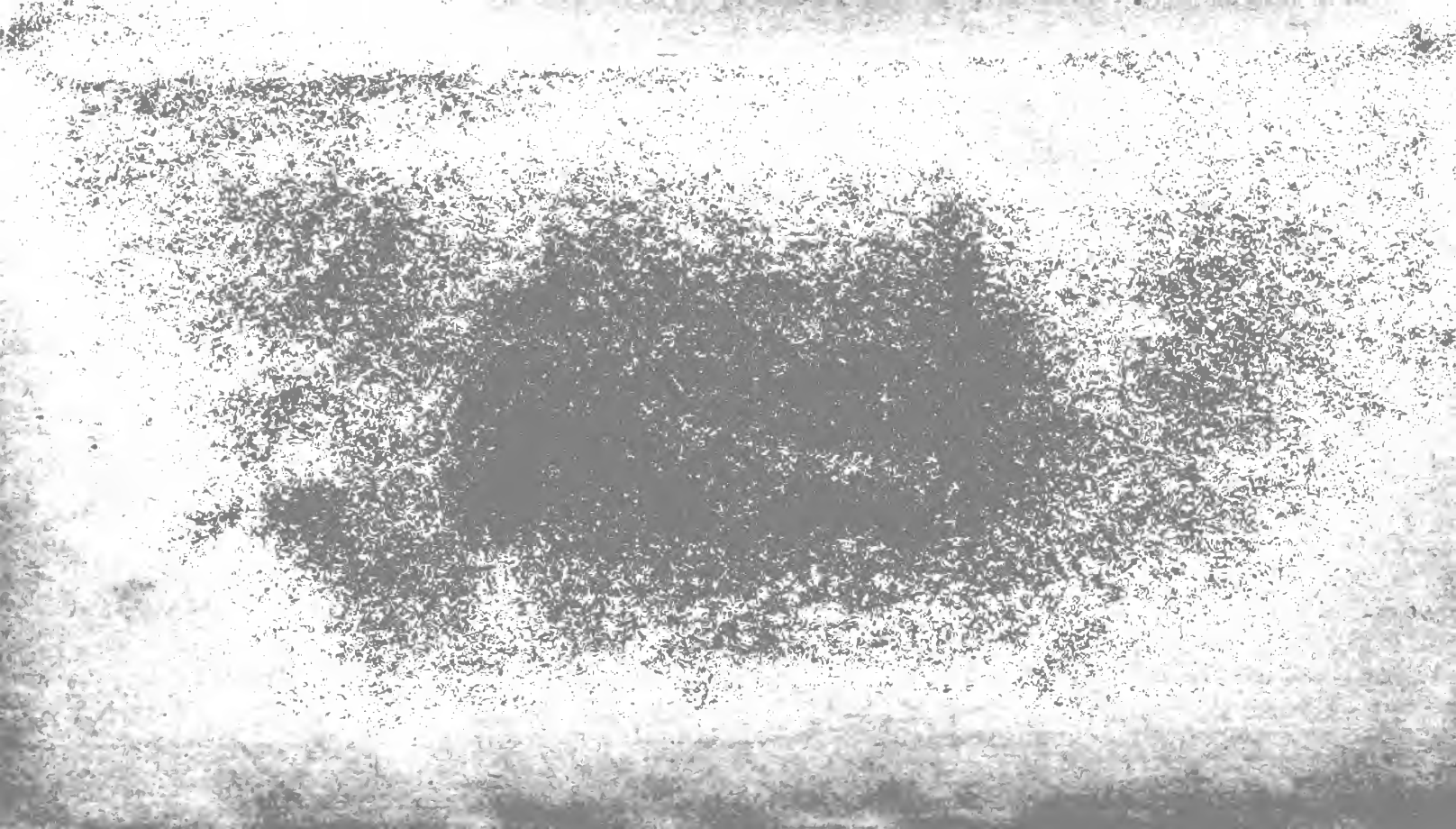

Enological Studies 2 and 3. Issued May 27, 1911.

U. S. DEPARTMENT OF AGRICULTURE,

BUREAU OF CHEMISTRY—BULLETIN No. 140.

H. W. WILEY, Chief of Bureau.

ENOLOGICAL STUDIES.

The Occurrence of Sucrose in Grapes.

The Sugar and Acid Content of Different Varieties of Grapes, Sampled at Frequent Intervals during Ripening and at Full Maturity.

BY

WILLIAM B. ALWOOD,

ENOLOGICAL CHEMIST.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1911.

ORGANIZATION OF BUREAU OF CHEMISTRY.

H. W. WILEY, *Chemist and Chief of Bureau.*
F. L. DUNLAP, *Associate Chemist; Acting Chief in absence of Chief.*
W. D. BIGELOW, *Assistant Chief of Bureau.*
F. B. LINTON, *Chief Clerk.*
A. L. PIERCE, *Editor.*
A. E. DRAPER, *Librarian.*

Division of Foods, W. D. BIGELOW, *Chief.*
Food Inspection Laboratory, L. M. TOLMAN, *Chief.*
Food Technology Laboratory, E. M. CHACE, *Chief and Assistant Chief of Division.*
Oil, Fat, and Wax Laboratory, H. S. BAILEY, *Chief.*

Division of Drugs, L. F. KEBLER, *Chief.*
Drug Inspection Laboratory, G. W. HOOVER, *Chief.*
Synthetic Products Laboratory, W. O. EMERY, *Chief.*
Essential Oils Laboratory, *under Chief of Division.*
Pharmacological Laboratory, WM. SALANT, *Chief.*

Chief Food and Drug Inspector, W. G. CAMPBELL.

Miscellaneous Division, J. K. HAYWOOD, *Chief.*
Water Laboratory, W. W. SKINNER, *Chief.*
Cattle-Food and Grain Laboratory, G. L. BIDWELL, *Acting.*
Insecticide and Fungicide Laboratory, C. C. MCDONNELL, *Chief.*
Trade Wastes Laboratory, *under Chief of Division.*

Contracts Laboratory, P. H. WALKER, *Chief.*

Dairy Laboratory, G. E. PATRICK, *Chief.*

Food Research Laboratory, M. E. PENNINGTON, *Chief.*

Leather and Paper Laboratory, F. P. VEITCH, *Chief.*

Microchemical Laboratory, B. J. HOWARD, *Chief.*

Physical Chemistry Laboratory, C. S. HUDSON, *Chief.*

Sugar Laboratory, A. H. BRYAN, *Chief.*

Sections:
Animal Physiological Chemistry, F. C. WEBER, *in Charge.*
Bacteriological Chemistry, G. W. STILES, *in Charge.*
Enological Chemistry, W. B. ALWOOD, *in Charge.*
Nitrogen, T. C. TRESCOT, *in Charge.*
Plant Physiological Chemistry, J. A. LE CLERC, *Chief.*

Food and Drug Inspection Laboratories:
Boston, B. H. SMITH, *Chief.*
Buffalo, W. L. DUBOIS, *Chief.*
Chicago, A. L. WINTON, *Chief.*
Cincinnati, B. R. HART, *Chief.*
Denver, R. S. HILTNER, *Chief.*
Detroit, H. L. SCHULZ, *Chief.*
Galveston, T. F. PAPPE, *Chief.*
Honolulu, Hawaii, E. B. BLANCHARD, *Acting.*
Kansas City, Mo., F. W. LIEPSNER, *Acting.*
Nashville, R. W. BALCOM, *Chief.*
New Orleans, C. W. HARRISON, *Chief.*
New York, R. E. DOOLITTLE, *Chief.*
Omaha, S. H. ROSS, *Chief.*
Philadelphia, C. S. BRINTON, *Chief.*
Pittsburg, M. C. ALBRECH, *Chief.*
Portland, Oreg., A. L. KNISELY, *Chief.*
St. Louis, D. B. BISBEE, *Chief.*
St. Paul, A. S. MITCHELL, *Chief.*
San Francisco, R. A. GOULD, *Chief.*
Savannah, W. C. BURNET, *Chief.*
Seattle, H. M. LOOMIS, *Chief.*

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Chemistry,
Washington, D. C., March 1, 1911.

Sir: I have the honor to submit for your approval the results of two enological studies by Wm. B. Alwood, of this bureau, in charge of this line of investigations at Charlottesville, Va. The results presented in this report, in so far as they relate to the occurrence of sucrose in large quantities in the commonly cultivated grapes, are new to science and constitute an important contribution to our knowledge of the chemical constituents of this fruit. The presence of sucrose in such a large amount, accompanied by a low acid content in the seedling studied in this instance, appears to produce a flavor quite unique among American grapes, and indicates that these data may be useful in future breeding work for the improvement of the flavor of our native varieties. The data secured on the chemical changes which occur during the ripening of grapes on the vines promise most important practical results, and this work will be continued until definite conclusions are established. The results so far obtained are of sufficient interest to be placed on record. I recommend that these studies be published as Bulletin 140, of the Bureau of Chemistry, under the general title of Enological Studies, continuing the series begun in Bulletin 129.

Respectfully,

H. W. Wiley,
Chief of Bureau.

Hon. James Wilson,
Secretary of Agriculture.

CONTENTS.

ENOLOGICAL STUDIES.

THE OCCURRENCE OF SUCROSE IN GRAPES.

OPINIONS FROM THE LITERATURE ON THE COMPOSITION OF GRAPES.

It has been generally stated throughout the literature that sucrose does not occur in grapes. While no actual data have been found on investigations made in foreign enological laboratories dealing specifically with the point, the following statements on the subject of the composition of grapes and wine are of interest in this connection.

J. L. W. Thudichum [1] says that cane sugar (sucrose) has never been found in grapes. Babo and Mach [2] say that while the presence of sucrose in grape must has been claimed, these observations are to be considered incorrect. Again, it was stated in 1910 that sucrose is not found in the grape.[3] Lucien Semichon,[4] director of the enological station of the Aube, enumerates the sugars present in the must of grapes as glucose, levulose, and invert sugar, but does not mention sucrose. J. Laborde,[5] professor of the institute of viticulture of the Gironde, discussing the nature of the sugars in grapes, mentions the researches of Mach, Bouffard, Dougast, and Pousset, and of Aimé Girard and Lindet, and notes the presence of dextrose and levulose only in the sugar content of grapes. Victor Sebastian [6] says the juice of the grape does not contain saccharose (sucrose). H. C. Gore,[7] in an article on the composition of Scuppernong, Concord, and Catawba grape juices, etc., notes the occurrence of sucrose in two of the three kinds of Scuppernong [8] grapes analyzed. His data shows 0.07 per cent in one variety and 1.90 per cent in another when

[1] A Treatise on Wines, London, 1896, p. 95.

[2] Weinbau und Kellerwirtschaft, Berlin, 1896, 3d ed., v. 2, p. 2.

[3] Kellerwirtschaft, 1910, 4th ed., v. 2, p. 3.

[4] Traité des maladies des vins, Montpellier, France, 1905, p. 2.

[5] Cours d'oenologie, Paris, 1907, pp. 9–10.

[6] Traité pratique de la preparation des vins de luxe, Montpellier, France, 1909, p. 84.

[7] J. Ind. Eng. Chem., 1909, 1 (7): 436.

[8] "Scuppernong" is, strictly speaking, a variety of the Rotundifolia species but the term is applied to all lighter colored varieties of Rotundifolia; the other two varieties examined were the James and the Mish, sucrose being found also in the latter.

treated by inversion and reduction in the usual manner. The presence of sucrose in these samples of Scuppernong grapes was confirmed by examination with the polariscope and by the use of invertase. While Mr. Gore reports polariscopic readings on other grape juices, namely, Concord and Catawba, which indicate the presence of sucrose, none was recovered from these varieties by inversion and reduction.

It is only fair to say that the very small amount of sucrose, 0.07 per cent, shown by inversion in the one variety of Scuppernong is so slight as to warrant the belief that sucrose may not have been actually present in this instance. It has been frequently shown in these investigations that inversion renders some substances active to copper which were not so before. Whether the slight increase in total sugar thus obtained should be interpreted as indicating sucrose, remains to be determined by further investigation. Mr. Gore seems to have been the first to note the occurrence of sucrose in the fruit of a species of Vitis, and the present report records the first discovery of sucrose in the varieties of the group commonly cultivated in the Eastern and Central States, namely, the Labrusca type, to which Concord, Catawba, and many of the best known grapes belong.

WORK OF 1909.

ORIGIN AND DESCRIPTION OF THE SEEDLING.

On September 8, 1909, while making some preliminary examinations of grapes at Sandusky, Ohio, a very attractive looking fruit, quite sweet, with a mild, pleasant flavor and low acidity, was found at a local store. The analysis, made in the usual manner, without inversion, showed that this fruit contained a very large proportion of nonsugar solids, and this fact suggested examination for sucrose, with the result that the large percentage of sucrose shown in the table was found. This very unusual characteristic led to an inquiry as to the source of the fruit, and from the dealer it was learned that it came from a vineyard at Venice, Ohio, about 3 miles west of Sandusky. Through the courtesy of the owner's son, Mr. William L. Steuk, the vineyard was inspected and the grapes examined. The vines appeared to lack vigor, the growth was uneven, and, though quite heavily hung with fruit, the bunches varied much in character and perfection of set of berries. The well-filled bunches were very beautiful and it appeared to be an important new grape if it could be successfully grown.

It was, therefore, decided to make a further study of this grape; and its very unusual chemical composition, together with its beauty and mild flavor—absolutely without foxiness—led to a sample being submitted to Mr. G. B. Brackett, the pomologist of the United States

Department of Agriculture, who replied as follows under date of September 30, 1909:

Upon testing the grape I find it to be exceedingly sweet and of excellent quality. I am not positive as to its identification, and desire to give the specimens more careful consideration.

Again, on October 23, after completing his examination of the fruit, Mr. Brackett wrote as follows, showing quite plainly that this grape is a seedling unknown to the fruit lists:

The grape which you sent me on September 18, said to be a seedling of Catawba, came duly, and as I wrote you at that time, I was unable to recognize it as any variety with which I am acquainted. I sent specimens to George C. Joscelyn, Fredonia, N. Y., and some to U. P. Hedrick, of the Agricultural Experiment Station, Geneva, N. Y., * * * Neither of these gentlemen recognizes it as any variety they have ever seen. I am therefore inclined to believe it is a seedling. The appearance and flavor of this grape are exceedingly good, but Professor Hedrick, who examined the last bunch sent out from here, wrote me that he considers it a very poor shipper, so the bunch could not have arrived at his office in very good condition * * *.

The suggestion made to Mr. Brackett by the writer that this grape was a seedling of Catawba rested upon a report which further inquiry did not support. After making as extensive an inquiry as possible, Mr. Steuk was able to give only a slight history of the grape. It appears that J. F. Munz, of Springfield, Ohio, brought it to the attention of the owner of the vineyard in 1904, and he propagated and planted about 100 vines, from which the samples in question were taken. Mr. Munz states that this seedling was found in a flower bed in which was planted a large collection of seeds received from Rochester, N. Y. It is scarcely probable, however, that the grape seed came with the flower seeds. It would appear more probable that grape seeds were accidentally dropped in this bed and that this plant is a chance seedling.

OTHER VARIETIES EXAMINED FOR SUCROSE.

The occurrence of sucrose in this seedling grape led naturally to further examinations for this form of sugar, with the result that three other varieties, namely, Catawba, Norton, and Montefiore, selected from the same vineyard during the season of 1909, appeared to show small amounts of sucrose by inversion, ranging from 0.04 per cent in Montefiore to 0.40 per cent in one sample of Catawba. These amounts of sucrose, as shown by reduction with Fehling solution, are too small to denote with any degree of certainty the presence of this sugar, and the Sandusky Laboratory was not equipped with a polariscope for checking the determinations. Sucrose was, however, found in considerable quantities in the well-known varieties Hayes, Worden, and Pocklington, as these were received in the regular work of the laboratory.

REEXAMINATION OF SAMPLES.

Some samples were saved, and on these determinations were repeated later at Stonehenge, as shown in the table (p. 14). These data confirm the finding of sucrose, as shown by the analysis made of the fresh samples, although the amounts found were smaller, thus indicating that inversion had taken place during the interim. This later examination, made December 30, shows a decline of over 2 grams per 100 cc of sucrose, and the results were in this case checked by the polariscope. The disappearance of sucrose on standing is further confirmed by Field No. 241, which was not analyzed until June 22, 1910, and showed on this date a decided loss of sucrose as compared with the samples of this seedling grape analyzed when fresh. The two samples designated as Field Nos. 122 and 179 were picked on October 1 and 6, respectively, duplicate samples of the expressed juice being preserved with mercuric chlorid and held until examined at the Stonehenge Laboratory, as just stated.

The fruit from the vines was carefully tested every two or three days until maturity, and it was found to deteriorate in quality, gradually becoming in a large measure characterless, flat, and insipid. This fact, however, does not detract from the scientific interest of the specimen. It is suggested that this seedling might be used for cross-pollenizing some of our strong-growing grapes, rich in acid and flavor, like the Catawba or others of the Labrusca and Æstivalis groups. Seedlings from such crosses might result in improving the character of vintage grapes in the direction of milder flavor and lower acid content.

WORK OF 1910.

CHECK WORK ON THE SUCROSE CONTENT OF THE SANDUSKY SEEDLING.

The discovery of sucrose in such large quantities in these several varieties of cultivated grapes led the Chief of the Bureau of Chemistry to direct that during 1910 samples be furnished to the Sugar Laboratory at Washington, so that an independent check might be made on the results already obtained at the Sandusky Laboratory, and also on the additional analyses to be made in the enological investigations during 1910. Only one variety was used for the check work, namely, the new seedling grape in which sucrose had been first discovered at Sandusky. The samples sent to the Bureau of Chemistry were analyzed by A. H. Bryan, Chief of the Sugar Laboratory, and portions of the same samples were sent to B. G. Hartmann at the Stonehenge Laboratory, Charlottesville, Va. The one sample used for the check work, Field No. 50, was taken September 16, 1910.

This sample was analyzed at Sandusky, and portions of the fresh fruit were sent to Bryan and Hartmann. Two specimens of juice from the same sample were also sent to each analyst, one of which had been preserved with mercuric chlorid and the other sterilized by heating the samples slowly to 98° C. in bottles tightly corked and submerged in water.

The results obtained by Bryan and Hartmann on these check samples are remarkably close as to total sugar, save on the fresh fruit, and this might easily have been due to variation in the samples sent out. It is not possible to sample grapes by bunches very closely, and this seedling shows marked differences in the total sugar in the analyses of the fresh fruit. But the bottled samples of grape juice were identical, as the results, with the exception of the polariscope readings, show. Regardless of these slight discrepancies, the results serve to establish beyond dispute the main point, i. e., that the results obtained at the Sandusky Laboratory are essentially correct and that this grape normally contains a large percentage of sucrose. Mr. Bryan also checked the sucrose determinations by inversion with invertase, and obtained a close agreement with the results on sucrose by acid inversion.

NOTES ON SAMPLES ANALYZED FOR SUCROSE IN 1910.

SEEDLING.

Field No. 1. Fine bunches; perfect berries; mostly colored.
12. Fine bunches; perfect berries; appear ripe to eye and taste.
24. Fine bunches; perfect berries; does not appear riper than previous sample.
50. Bunches small; perfect berries; practically ripe.
131. Bunches small; perfect berries; fully ripe.

HAYES.

34. Bunches small; berries medium; not fully ripe.

ILLINOIS CITY.

141. Bunches medium; good fruit.

NECTAR.

293. Fine compact bunches; large berries; excellent fruit.

POCKLINGTON.

4. Fine bunches and berries; quite green.
14. Small bunches; fine berries; not ripe.
25. Small bunches; fine berries; not ripe.
48. Fine bunches and berries; nearly ripe.
66. Fine bunches and berries; ripe.

(By mistake the pickers harvested the reserved vines and no further examinations could be made of this variety.)

WORDEN.

Field No. 1. Very fine fruit; nearly ripe.
3. Very fine fruit; some berries bursting.
13. Very fine fruit; appears fully ripe.
27. Very fine fruit; appears fully ripe.
46. Good fruit; fully ripe.
63. Bunches small; good berries; fully ripe.
87. Good fruit; overripe.
137. Good condition, but overripe.
191. Small bunches; berries sound; overripe.
37. Large, good bunches; not fully ripe.
38. Very fine fruit; not fully ripe.
52. Very good fruit; not fully ripe.
93. Fruit only ordinary; fully ripe.

GENERAL DISCUSSION OF RESULTS.

The examinations of the seedling grape in both years covered the period from the date it became barely edible until it was overripe, in each case a period of 22 days. The total sugar content in the analysis of the fresh fruit, as shown by the table, varied about 3 per cent in the first year and about 5 per cent in the second year. The ratio of reducing sugar to sucrose content varied from 1:0.80 to 1:1.04 in 1909 and from 1:1 to 1:1.19 in 1910, thus showing a fairly constant proportion between these two forms of sugar. The total acid content decreased about one-third in each year during the period the variety was under examination.

During the season of 1909 only one sample of Hayes and two each of Pocklington and Worden were examined at the Sandusky Laboratory. All of these showed quite a large amount of sucrose, hence in 1910 it was decided to examine these varieties more carefully, but only one sample of Hayes could be procured, as it is not grown to any extent. Of Pocklington and Worden, however, quite an extensive series of samples was obtained from the Steuk Vineyard at Venice, Ohio, and of the Worden grapes several additional samples from widely separated points were also analyzed. The analytical data in every instance confirmed the results obtained in 1909. None of the data, either in the case of the seedling or of these well-known varieties, indicates that sucrose occurs in greater quantities at any given period of maturity. In fact, the variations in the amount of sucrose obtained from the same variety of grapes at different dates are quite irregular. This fact does not admit of explanation by the data so far determined, but as the analysts checked the results carefully it is believed that they are correct.

During the season of 1910 careful gravimetric tests were made for sucrose whenever there was any indication of its presence, and

in two instances, namely, the varieties Illinois City and Nectar, grown at Geneva, N. Y., appreciable quantities of sucrose were found. These varieties are not much grown, but it is interesting to note that they also belong to the Labrusca group of our native grapes.

DETAILED STATEMENT OF ANALYTICAL DATA FOR 1909 AND 1910.

The chemical data for the samples analyzed both in 1909 and 1910 are given in the table on pages 14–15.

Data on the occurrence of sucrose in grapes, 1909 and 1910.

Variety and field number.	Date picked.	Specific gravity.	Total solids.	Sugar-free solids.	Reducing sugar.	Sucrose by inversion.	Total sugar as invert.	Total acid as tartaric.	Polarization (normal weight, 200 mm tube).				Sucrose by polarization.	Place and date of analysis and name of analyst.
									Direct 20° C.	Acid inversion 20° C.	Invertase inversion 20° C.	Acid inversion 87° C.		
Seedling: [1]			*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	*Per ct.*	° V.	° V.	° V.	° V.	*Per ct.*	
34	Sept. 18, 1909	1.0700	16.97	2.43	7.94	6.60	14.89	0.635						Analyzed at Sandusky, Ohio, by Hartmann and Eoff, 1909.[2]
100	Sept. 28, 1909	1.0719	17.41	2.48	8.28	6.65	15.27	.542						Do.
122	Oct. 1, 1909	1.0845	20.25	2.72	8.56	8.97	17.99	.480						Do.
147	Oct. 4, 1909	1.0695	16.86	2.03	7.58	7.25	15.21	.404						Do.
179	Oct. 6, 1909	1.0740	17.89	2.07	8.45	7.36	16.21	.440						Do.
241	Oct. 9, 1909	1.0778	18.74	1.57	13.81	3.44	17.42	.418						Analyzed at Stonehenge Laboratory by Hartmann, June 22, 1910.
122		1.0833	19.99	2.00	11.37	6.61	18.33	.388	+1.6	−7.1			7.11	Sample preserved and held in bottle until Dec. 30, 1909, analyzed by Hartmann.
179		1.0745	18.00	1.41	11.65	4.94	16.85	.420	+ .3	−6.3			5.35	Do.
2	Sept. 4, 1910	1.0712	17.25	2.29	7.49	7.49	15.37	.616						Analyzed at Sandusky, Ohio, by Eoff and Treuthardt, 1910.
12	Sept. 9, 1910	1.0832	19.96	2.08	8.44	9.44	18.37	.561						Do.
24	Sept. 13, 1910	1.0761	18.36	2.03	8.00	8.34	16.77	.495						Do.
50	Sept. 16, 1910	1.0834	20.00	2.09	8.18	9.74	18.42	.492						Do.
131	Sept. 26, 1910	1.0937	22.29	2.39	9.33	10.57	20.45	.401						Do.
50	Sept. 16, 1910	1.0781			8.78	8.06	17.27	.409	+4.05	−7.00			8.32	Fresh sample analyzed by Hartmann at Stonehenge Laboratory, Sept. 19, 1910.
50	do	1.0808	19.46	1.77	7.88	9.81	18.21		+5.65	−6.80	−6.45	−0.88	9.38	Fresh sample analyzed by Bryan, Bureau of Chemistry, Sept. 20, 1910.
50	do	1.0817			9.30	8.74	18.50	.437	+4.95	−7.00			9.00	Sterilized sample analyzed by Hartmann at Stonehenge Laboratory, Sept. 19, 1910.
50	do	1.0838	20.14	1.99	9.64	8.51	18.57		+4.35	−6.40	−6.40	.0	8.10	Sterilized sample analyzed by Bryan, Bureau of Chemistry, Sept. 20, 1910.
50	do	1.0815			8.38	9.75	18.63	.451	+6.20	−7.05			9.98	Preserved sample analyzed by Hartmann, Stonehenge Laboratory, Sept. 19, 1910.
50	do	1.0836	20.09	2.03	8.38	9.68	18.57		+5.88	−6.40	−6.40	.0	9.25	Preserved sample analyzed by Bryan, Bureau of Chemistry, Sept. 20, 1910.
131	Sept. 26, 1910		20.05		8.26	10.67	19.49		+6.30	−7.40				Fresh sample analyzed by Bryan, Bureau of Chemistry, 1910.
Hayes: [3]														
139	Oct. 4, 1909	1.0806	19.38	2.58	11.56	5.24	17.07	.826						Hartmann and Eoff, 1909.[4]
34	Sept. 13, 1910	1.0683	16.60	2.62	9.70	4.27	14.19	1.047						Eoff and Treuthardt, 1910.

Illinois City: [5]														
141	Sept. 28, 1910	1.0773	18.63	2.15	13.48	2.91	16.53	.926						Do.
Nectar: [5]														
293	Oct. 18, 1910	1.0762	18.39	2.53	12.59	3.30	16.06	1.167						Do.
Pocklington: [6]														
[3] 141	Oct. 4, 1909	1.0742	17.93	2.51	11.10	4.32	15.64	.862						Hartmann and Eoff, 1909.
207	Oct. 8, 1909	1.0753	18.19	2.33	12.02	3.82	16.05	.611						Do.
4	Sept. 4, 1910	1.0564	13.83	3.07	8.25	2.52	10.90	1.438						Eoff and Treuthardt, 1910.
14	Sept. 9, 1910	1.0617	15.07	2.67	9.51	2.88	12.55	1.074						Do.
25	Sept. 13, 1910	1.0710	17.21	2.31	10.17	4.73	15.15	.917						Do.
48	Sept. 16, 1910	1.0740	17.89	2.28	14.38	1.23	15.58	.946						Do.
66	Sept. 20, 1910	1.0744	17.97	2.61	10.73	4.64	15.62	1.019						Do.
Worden: [6]														
142	Oct. 4, 1909	1.0758	18.29	2.70	11.42	4.17	15.82	.725						Hartmann and Eoff, 1909.
194	Oct. 7, 1909	1.0744	17.97	1.90	12.54	3.54	16.26	.594						Do.
1	Sept. 1, 1910	1.0636	15.50	2.91	9.09	3.49	12.77	1.206						Eoff and Treuthardt, 1910.
3	Sept. 4, 1910	1.0582	14.25	2.88	9.59	1.77	11.45	1.184						Do.
13	Sept. 9, 1910	1.0658	16.01	2.23	10.95	2.84	13.94	.767						Do.
27	Sept. 13, 1910	1.0757	18.26	2.06	12.35	3.85	16.41	.768						Do.
[7] 46	Sept. 16, 1910	1.0762	18.39	2.49	6.56	9.34	16.40	.740						Do.
63	Sept. 20, 1910	1.0806	19.38	2.23	10.60	6.54	17.46	.676						Do.
87	Sept. 23, 1910	1.0861	20.61	2.50	14.92	3.18	18.27	.644						Do.
137	Sept. 26, 1910	1.0842	20.18	2.25	10.88	7.05	18.30	.585						Do.
199	Sept. 30, 1910	1.0806	20.72	2.40	11.55	6.76	18.66	.621						Do.
[5] 37	Sept. 14, 1910	1.0562	13.79	2.58	7.74	3.47	11.39	1.221						Do.
[5] 38	Sept. 15, 1910	1.0571	14.00	2.44	7.62	3.94	11.77	1.241						Do.
[8] 52	Sept. 16, 1910	1.0521	12.82	2.60	6.67	3.54	10.41	1.304						Do.
[9] 93	Sept. 24, 1910	1.0548	13.46	2.27	9.23	1.97	11.31	.967						Do.

[1] Grown by E. L. Steuk, at Venice, Ohio.

[2] No polariscopic readings were made on the samples analyzed at Sandusky, as the laboratory at that point was not equipped with an instrument.

[3] Grown at Put-in-Bay, Ohio, by G. F. Rotert.

[4] No polariscopic readings made. This and all subsequent samples analyzed at Sandusky, Ohio.

[5] Grown by the Agricultural Experiment Station at Geneva, N. Y.

[6] All except numbers otherwise assigned grown at Venice, Ohio, by E. L. Steuk.

[7] The determination of sucrose in this instance is out of accord with the results on the other samples; as there was no duplicate sample, the figures could not be checked.

[8] Grown by the New York Agricultural Experiment Station at Fredonia, N. Y.

[9] Grown at Pen Yan, N. Y., by Hart and Scott.

THE SUGAR AND ACID CONTENT OF DIFFERENT VARIETIES OF GRAPES, SAMPLED AT FREQUENT INTERVALS DURING RIPENING AND AT FULL MATURITY.

These examinations, which were begun during the season of 1909 and extended during 1910, are to be considered as preliminary to a more comprehensive study. It should be understood that analyses of these small samples, however carefully selected, do not always represent accurately the crop as a whole, but the results are reliable as an indication of the changes in composition taking place in the fruit during ripening.

EXAMINATIONS MADE DURING 1909.

The season of 1909 was unfavorable to the proper ripening of the grape crop in the Lake Erie district. For many days the fruit made no progress, and later there was severe cold weather, so that many crops, especially the Catawbas, were left without proper foliage for the completion of the ripening process. Many tons of these grapes did not ripen.

For these observations three important varieties of grapes were selected, namely, Catawba, Montefiore, and Norton, and to these was added the new seedling already discussed, which was sampled from September 18 to October 9, thus covering a longer period than in the case of the other varieties. All of the 1909 samples were procured from a vineyard situated at Venice, Ohio, about 3 miles west of Sandusky, a few hundred yards distant from Lake Erie, and only a few feet above it. This vineyard was exceptionally well cultivated and in prime condition, barring some slight damage by hail. The soil is a black loam overlying limestone rock.

The first samples of all, save the seedling, were taken on September 28, and the following notes were made:

Catawba.—Bunches small, fruit unripe, some berries green.
Montefiore.—Fruit ripe and in good condition.
Norton.—Fruit ripe and in good condition.
Seedling.—Bunches plump, not fully ripe.

On October 4 the notes show that all samples were in good condition and not overripe, save Norton, which was then somewhat wilted. In every instance average bunches were selected and crushed without removing a single grape. As in previous studies, the samples were crushed by hand, the juice strained through a double thickness of cheesecloth, using slight pressure toward the end, and then filtered through cotton.

The tabular data on the sugar and the acid content, and the changes in each of these constituents for the four varieties during the seven days covered, are interesting and important. However, the figures would have been much more valuable if the examinations had been begun before the season was so far advanced. Especially is this true of Montefiore and Norton. The following tabular statement gives in condensed form the salient facts as to changes in sugar and acid content of the several varieties during the period covered by the analyses. In all cases the figures given under total sugar are reducing sugars calculated as invert.

Comparison of sugar and acid determinations made on different varieties at different dates, 1909.

Variety and date.	Sugar.		Acid.	
	Total.	Increase or decrease.	Total.	Increase or decrease.
1909.	*Per cent.*		*Per cent.*	
Catawba:				
Sept. 28	14.46		1.525	
Oct. 1	16.00	+1.54	1.322	−0.203
4	16.90	+ .90	1.066	− .256
Total differences in sugar and in acid [1]		[2] +2.44		[3] − .459
Montefiore:				
Sept. 28	19.91		.705	
Oct. 1	19.72	− .19	.748	+ .043
4	19.66	− .06	.590	− .158
Total differences in sugar and in acid		− .25		− 115
Norton:				
Sept. 28	18.09		1.984	
Oct. 1	18.63	+ .54	1.705	− .279
4	18.10	− .53	1.589	− .116
Total differences in sugar and in acid		+ .01		− .395
Seedling:				
Sept. 18	14.89		.635	
28	15.27	+ .38	.542	− .093
Oct. 1	17.99	+2.27	.480	− .062
4	15.21	−2.78	.404	− .076
6	16.21	+1.00	.440	+ .036
9	17.42	+1.21	.418	− .022
Total differences in sugar and in acid		[4] +2.53		[5] − .217

[1] The total increase or decrease in the sugar or the acid content is the difference between the first and the last analysis, regardless of the maximum shown during growth.
[2] Percentage increase of sugar, 16.8.
[3] Ratio—loss of acid to increase of sugar, 1 : 5.3.
[4] Percentage increase of sugar, 17.
[5] Ratio—loss of acid to increase of sugar, 1 : 11.6.

For the Catawba grapes the results show an important increase in sugar and an equally important decrease in acid. The observations were not continued long enough to be conclusive, but they are of much interest. The harvesting of all of the fruit save the Catawba for vintage purposes interfered with further comparisons after October 4. Although the Catawba grapes were not harvested until October 28, 24 days after the last analysis given in the table, at that time (October 28) they contained only 17.17 per cent of total sugar, a rise of 0.27 per cent as compared with the data of October 4, and the acid was 1.217 per cent, a rise of 0.151 per cent. The analysis,

however, was made of fruit crushed in a power mill and then passed through a hydraulic press. It is doubtful, considering the condition of these vines, whether the quality of the grapes was improved by allowing them to hang on the vines during the cold wet October days.

The Montefiore grapes show an insignificant loss of sugar for the period as a whole and a very appreciable loss of acid. In the case of the Norton the sugar remained practically the same, but the acid was greatly decreased. The apparent gain for the first period and the loss during the second period illustrate the difficulty of sampling a crop accurately.

The seedling showed a decided gain in sugar and an important loss in acid considering the entire period, but there was a phenomenal gain in sugar during the second period and an equal loss during the next one. This must be credited to the uneven growth and ripening of this seedling, normal samples being hard to obtain during the fall of 1909. The full analysis of this grape is given in the table on page 14.

EXAMINATIONS MADE DURING 1910.

ADDITIONAL VARIETIES EXAMINED AND THEIR SAMPLING.

During the season of 1910 a more extended series of samples were analyzed and several more varieties included in the investigation. Montefiore was excluded because it had been so injured by a late spring frost that samples could not be secured near Sandusky. As in the previous year, Catawba and Norton were taken from the Steuk vineyard at Venice, Ohio, and in addition the Concord, Delaware, and Ives grapes were sampled. Brighton and Clinton varieties were obtained from Mr. John Schonhardt's vineyard situated near by and also on the lake. The list of varieties as thus extended includes the three most prominent types of families of our native cultivated grapes, namely, Labrusca, Æstivalis, and Riparia.

The grape crop was not large in 1910, as many of the varieties grown on the border of the lake were injured by the freeze in May, which, although it rendered much of the fruit inferior in character and appearance, did not necessarily injure its value as a chemical sample. Furthermore, the berry moth made such ravages during the ripening of the fruit as to interfere with holding some of the varieties on the vines as long as had been intended.

The period covered by the sampling in 1910 was much longer than in 1909, ranging from 16 days in the case of the Brighton grapes to 46 days in the case of the Clinton variety. On the whole the observations covered a sufficient length of time, except for the Brighton, Catawba, and Norton; in the case of the last two varieties the ravages of the berry moth made sampling for a longer period practically impossible. It was found necessary to remove all moth-infested and wormy grapes from the samples taken during the latter part of the

season, but otherwise the bunches were crushed whole without removing either the immature grapes or the stems and pedicels.

Several plants of each variety were selected and the right to use the entire crop from these was secured, so that the character and validity of the samples might be better controlled. In this discussion the data on the acid and sugar content of the Pocklington and Worden varieties, and of the seedling studied for the determination of sucrose, have all been included. The full analytical data for these last three varieties are given in the table on page 14.

DETAILED DATA ON TOTAL SUGAR AND ACID CONTENT.

The following table gives a succinct comparison of the total sugar and acid content of the several varieties at the dates on which they were sampled:

Comparison of the sugar and the acid content of different varieties as determined on different dates, 1910.

Date and variety.	Sugar.		Acid.	
	Total.	Increase or decrease.	Total.	Increase or decrease.
1910.				
Brighton:	*Per cent.*		*Per cent.*	
Sept. 4	15.63		0.782	
12	19.72	+4.09	.578	−0.204
20	19.41	− .31	.611	+ .033
Total differences in sugar and in acid		[1] +3.78		[2] − .171
Catawba:				
Sept. 4	8.14		2.954	
9	10.46	+2.32	2.338	− .616
13	12.77	+2.31	2.004	− .334
16	14.12	+1.35	1.716	− .288
20	15.33	+1.21	1.711	− .005
23	16.11	+ .78	1.491	− .220
26	17.60	+1.49	1.232	− .259
30	17.27	− .33	1.010	− .222
Total differences in sugar and in acid		[3] +9.13		[4] −1.944
Clinton:				
Sept. 4	12.61		2.621	
9	15.03	+2.42	2.148	− .473
13	16.34	+1.31	2.136	− .012
16	16.34	.00	1.895	− .241
22	19.55	+3.21	1.785	− .110
Oct. 3	18.93	− .62	1.498	− .287
11	19.95	+ 1.02	1.496	− .002
20	20.83	+ .88	1.496	.000
Total differences in sugar and in acid		[5] + 8.22		[6] −1.125
Concord:				
Sept. 4	11.75		1.177	
10	13.35	+ 1.60	.867	− .310
13	15.77	+ 2.42	.790	− .057
16	16.76	+ .99	.785	− .005
20	16.96	+ .20	.677	− .108
23	18.09	+ 1.13	.768	+ .091
26	18.69	+ .60	.615	− .153
Total differences in sugar and in acid		[7] + 6.94		[8] − .562

[1] Percentage increase of sugar, 24.2.
[2] Ratio, loss of acid to increase of sugar, 1 : 2.2.
[3] Percentage increase of sugar, 112.1.
[4] Ratio, loss of acid to increase of sugar, 1 : 4.7.
[5] Percentage increase of sugar, 65.2.
[6] Ratio, loss of acid to increase of sugar, 1 : 7.3.
[7] Percentage increase of sugar, 59.1.
[8] Ratio, loss of acid to increase of sugar, 1 : 12.3.

Comparison of the sugar and the acid content of different varieties as determined on different dates, 1910—Continued.

Date and variety.	Sugar.		Acid.	
	Total.	Increase or decrease.	Total.	Increase or decrease.
Delaware:	*Per cent.*		*Per cent.*	
Sept. 4	13.25		1.426	
9	15.17	+ 1.92	1.117	−0.309
13	17.08	+ 1.91	.944	− .173
16	17.68	+ .60	.929	− .015
20	18.31	+ .63	.914	− .015
23	19.63	+ 1.32	.761	− .153
26	21.51	+ 1.88	.736	− .025
30	21.05	− .46	.660	− .076
Total differences in sugar and in acid		[1] +7.80		[2] − .766
Ives:				
Sept. 4	10.65		1.003	
9	11.54	+ .89	.799	− .204
13	13.13	+ 1.59	.762	− .037
16	14.30	+ 1.17	.857	+ .085
20	14.76	+ .46	.797	− .060
23	13.69	− 1.07	.757	− .040
26	13.98	+ .29	.674	− .083
Total differences in sugar and in acid		[3] + 3.33		[2] − .329
Norton:				
Sept. 4	6.79		2.927	
9	10.73	+ 3.94	2.373	− .654
13	12.89	+ 2.16	2.000	− .373
16	15.20	+ 2.31	2.067	+ .067
20	17.43	+ 2.23	1.837	− .230
23	17.92	+ .49	1.605	− .232
26	18.88	+ .96	1.493	− .112
Total differences in sugar and in acid		[4] +12.09		[5] −1.434
Pocklington:				
Sept. 4	10.90		1.438	
9	12.55	+ 1.65	1.074	− .364
13	15.15	+ 2.60	.917	− .157
16	15.58	+ .43	.946	+ .029
20	15.62	+ .04	1.019	+ .073
Total differences in sugar and in acid		[6] + 4.72		[7] − .419
Seedling:				
Sept. 4	15.37		.616	
9	18.37	+ 3.00	.561	− .055
13	16.77	− 1.60	.495	− .066
16	18.42	+ 1.65	.488	− .007
26	20.45	+ 2.03	.401	− .087
Total differences in sugar and in acid		[8] + 5.08		[9] − .215
Worden:				
Sept. 1	12.77		1.206	
4	11.45	− 1.32	1.184	− .022
9	13.94	+ 2.49	.767	− .427
13	16.41	+ 2.47	.768	+ .001
16	16.40	− .01	.740	− .028
20	17.46	+ 1.06	.676	− .064
23	18.27	+ .81	.644	− .032
26	18.30	+ .03	.585	− .059
30	18.66	+ .36	.621	+ .036
Total differences in sugar and in acid		[10] + 5.89		[2] − .585

[1] Percentage increase of sugar, 58.8.
[2] Ratio, loss of acid to increase of sugar, 1 : 10.1.
[3] Percentage increase of sugar, 31.3.
[4] Percentage increase of sugar, 178.
[5] Ratio, loss of acid to increase of sugar, 1 : 8.4.
[6] Percentage increase of sugar, 43.3.
[7] Ratio, loss of acid to increase of sugar, 1 : 11.2.
[8] Percentage increase of sugar, 33.1.
[9] Ratio, loss of acid to increase of sugar, 1 : 23.6.
[10] Percentage increase of sugar, 46.1.

DISCUSSION OF ANALYTICAL DATA.

It is manifestly misleading to compare data on the ripening of grapes by the calendar days, rather than by periods covering comparative conditions of ripening. But whatever may be done along the line of such a comparison is necessarily arbitrary and largely a matter of personal opinion. In the following comments no comparison of each variety with the others is intended; the purpose of the discussion is rather to call attention to the salient features in each case. Comparisons of technical importance must await the accumulation of much data covering a series of years, and even then those of the most value will in the writer's estimation be the comparisons made between the data on a given variety. Such data as are here presented, when sufficiently extended, may reasonably be expected to indicate important details in methods of harvesting the several varieties.

The results for Brighton have very little significance and indicate that the crop had passed its maximum condition before the last sample was taken. In this case the sampling should have begun 10 days sooner.

For Catawba the total sugar does not in any sample reach the average of the general crop of that section, but the acid is about at the minimum for this variety on the date when the last sample was taken. At that time the sugar had apparently decreased, but the difference is too slight to be considered, in view of the difficulty of taking two samples of grapes from the same lot which do not show similar differences in composition. This variety in 1910 was high in sugar wherever the growth conditions were good. The fruit as sampled more than doubled in sugar after the berries began to color and lost more than half of the acid content shown in the first sample. The very decided loss of acid even for the last seven days, amounting to 0.481 per cent, is most important, although the sugar increased only 1.16 per cent. The ratio of increase of sugar to loss of acid is very low for this variety.

Clinton was sampled for a longer period than any other variety. It is well known to students of grapes that though this variety colors early, it hangs well and should be permitted to remain on the vines as long as possible. Yet the custom of the Lake Erie district is to harvest this variety before Catawba. The analyses show that there was some increase of sugar up to the last sample, but the acid remained constant after October 3. The actual gain in sugar and loss of acid is not so important as for Catawba, but the gain in sugar in proportion to the loss of acid is greater.

The Concord samples were in remarkably good condition at the last analysis. This variety is invariably harvested before it is ripe in the Sandusky district. While neither the gain of sugar nor the loss

of acid is remarkable in total amount, yet the results show a great improvement in the fruit as sampled for this study as compared with the samples harvested for the vintage. (See detailed analyses of varieties, p. 24, for these data.) The proportional increase of sugar to loss of acid for this variety is above that of any of the strictly wine grapes.

The data for Delaware show what a very fine wine grape this is when fully matured. The rise in sugar during the 26-day period when this variety was sampled was not so great in proportion to the total as was found in the Catawba, Clinton, or Norton, but the drop of over one-half in total acid is of the greatest significance, and the proportional increase of sugar to acid lost is greater than in the other varieties of strictly wine grapes just mentioned.

Ives was uniformly poor in quality in 1910, but the data as to acid decrease and proportional sugar increase are important.

Norton shows a consistent and steady rise in sugar and a notable decrease in acid during the period of sampling. Yet in the maximum sample the sugar is lower and the acid higher than is usual for this variety when grown in the most suitable environment. Evidently this grape requires a longer growing season than is usual at Sandusky. The acid-sugar ratio, however, greatly exceeds the figure for Catawba, and the percentage increase of sugar is the greatest recorded for any variety.

Pocklington is of too little consequence as a vintage fruit to warrant an extended study of the character here undertaken, and the data are presented only because this variety was under observation in the sucrose investigation. The Seedling, whose peculiar composition led to the sucrose investigation, is also included (see p. 20). The commercial importance of this grape in its present development is slight, but the remarkable fact that its ratio of loss of acid to increase of sugar is 1: 23.6 is a most notable item in the chemistry of the grape. If it be found possible to transmit the peculiarities of this variety to a seedling progeny, accompanied by greater vigor, a valuable product should result.

Worden is so much like Concord that chemically it is not necessary to study the two varieties in an investigation of this nature. The record presented is also taken from the sucrose work. It is, however, notable that this variety when fully ripe is rich in sugar, with a proper proportion of acid.

NOTES MADE ON SAMPLES ON THE DATES OF ANALYSIS, 1910.

BRIGHTON.

Field No. 8. Good fruit, well colored and sweet.
23. Large fine bunches, fully ripe.
68. Fine fruit, good condition.

CATAWBA.

Field No. 10. Average bunches, berries small but commencing to color.
19. Good full bunches, berries small but commencing to color.
31. Bunches medium, berries small, about half colored.
47. Bunches large, berries undersized, about two-thirds colored.
65. Bunches medium, berries small, coloring rapidly.
86. Good fruit, not ripe yet.
134. Average fruit, not ripe yet.
200. Average fruit, in good condition, not fully ripe. Crop picked because of ravages of berry moth.

CLINTON.

Field No. 7. Bunches small, well colored but not ripe.
17. Good fruit, not ripe.
32. Bunches small, good berries, well colored, not ripe.
57. Poor bunches.
82. Fair fruit, not ripe.
90. Fair fruit, not ripe.
228. Poor bunches.
350. Ragged bunches, nearly ripe.
502. Good sample, appears to be ripe.

CONCORD.

Field No. 9. Fair fruit, berries small, colored, not ripe.
18. Fair fruit, berries small, colored, not ripe.
28. Fair fruit, berries small, fully colored, not ripe.
43. Inferior bunches.
60. Fair bunches, not yet ripe.
84. Inferior bunches, fruit sound, almost ripe.
138. Inferior bunches, fruit sound, ripe.

DELAWARE.

Field No. 11. Average bunches, about half colored.
20. Medium bunches, good berries, almost colored.
30. Large bunches, good condition, fully colored.
44. Fair fruit, not fully ripe.
64. Fair fruit, nearly ripe.
89. Good fruit, nearly ripe.
136. Fair bunches, crop already picked for wine.
201. Large full bunches, fully ripe.

IVES.

Field No. 6. Bunches small, berries well colored.
16. Bunches small, berries well colored.
26. Bunches small.
45. Inferior fruit.
61. Inferior fruit, not yet ripe.
88. Small bunches, not yet ripe.
135. Small bunches, about ripe.

NORTON.

Field No. 5. Large bunches, one-half berries reddish color.
15. Fair bunches, coloring rapidly.
29. Fair bunches, nearly all berries colored.
49. Fair bunches.
62. Fair bunches, not yet ripe.
85. Fair bunches.
133. Inferior fruit, picked for wine Sept. 28.

DETAILED STATEMENT OF ANALYTICAL DATA FOR 1909 AND 1910.

The following table contains the detailed data obtained by the analyses of ripening grapes during both 1909 and 1910:

Results on eight varieties of grapes analyzed on different dates during ripening, 1909 and 1910 (Hartmann, Eoff, and Treuthardt, analysts).

Variety and field number.	Date of picking.	Specific gravity.	Solids.	Sugar-free solids.	Total sugar (invert).	Total acid as tartaric.
Brighton:[1]			*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
8	Sept. 4, 1910	1.0738	17.84	2.21	15.63	0.782
13	Sept. 12, 1910	1.0901	21.50	1.77	19.72	.578
68	Sept. 20, 1910	1.0928	22.09	2.59	19.41	.611
Catawba:[2]						
99	Sept. 28, 1909	1.0725	17.54	3.10	14.46	1.525
121	Oct. 1, 1909	1.0785	18.90	2.92	16.00	1.322
148	Oct. 4, 1909	1.0802	19.29	2.42	16.90	1.066
10	Sept. 4, 1910	1.0510	12.57	4.43	8.14	2.954
19	Sept. 9, 1910	1.0586	14.34	3.88	10.46	2.338
31	Sept. 13, 1910	1.0665	16.17	3.39	12.77	2.004
47	Sept. 16, 1910	1.0709	17.18	3.06	14.12	1.716
65	Sept. 20, 1910	1.0793	19.09	3.75	15.33	1.711
86	Sept. 23, 1910	1.0814	19.57	3.45	16.11	1.491
134	Sept. 26, 1910	1.0839	20.11	2.51	17.60	1.232
200	Sept. 30, 1910	1.0804	19.34	2.07	17.27	1.010
Clinton:[1]						
7	Sept. 4, 1910	1.0703	17.05	4.44	12.61	2.621
17	Sept. 9, 1910	1.0793	19.09	4.06	15.03	2.148
32	Sept. 13, 1910	1.0845	20.24	3.90	16.34	2.136
57	Sept. 16, 1910	1.0852	20.41	4.07	16.34	1.895
82	Sept. 22, 1910	1.0972	23.06	3.51	19.55	1.785
228	Oct. 3, 1910	1.0915	21.79	2.87	18.93	1.498
350	Oct. 11, 1910	1.0963	22.89	2.92	19.95	1.496
502	Oct. 20, 1910	1.0995	23.55	2.73	20.83	1.496
Concord:[2]						
9	Sept. 4, 1910	1.0580	14.21	2.46	11.75	1.177
18	Sept. 10, 1910	1.0637	15.53	2.18	13.35	.867
28	Sept. 13, 1910	1.0743	17.96	2.19	15.77	.790
43	Sept. 16, 1910	1.0798	19.19	2.44	16.76	.785
60	Sept. 20, 1910	1.0800	19.24	2.28	16.96	.677
84	Sept. 23, 1910	1.0892	21.30	3.21	18.09	.768
138	Sept. 26, 1910	1.0865	20.69	2.00	18.69	.615
Delaware:[2]						
11	Sept. 4, 1910	1.0669	16.26	3.01	13.25	1.426
20	Sept. 9, 1910	1.0737	17.81	2.64	15.17	1.117
30	Sept. 13, 1910	1.0803	19.31	2.23	17.08	.944
44	Sept. 16, 1910	1.0831	19.94	2.25	17.68	.929
64	Sept. 20, 1910	1.0919	21.89	3.59	18.31	.914
89	Sept. 23, 1910	1.0943	22.43	2.81	19.63	.761
136	Sept. 26, 1910	1.1004	23.76	2.25	21.51	.736
201	Sept. 30, 1910	1.0972	23.06	2.01	21.05	.660
Ives:[2]						
6	Sept. 4, 1910	1.0548	13.46	2.81	10.65	1.003
16	Sept. 9, 1910	1.0564	13.84	2.29	11.54	.799
26	Sept. 13, 1910	1.0631	15.39	2.26	13.13	.762
45	Sept. 16, 1910	1.0694	16.85	2.54	14.30	.857
61	Sept. 20, 1910	1.0733	17.74	2.97	14.76	.797
88	Sept. 23, 1910	1.0700	16.97	3.28	13.69	.757
135	Sept. 26, 1910	1.0675	16.40	2.43	13.98	.674
Montefiore:[2]						
101	Sept. 28, 1909	1.0960	22.80	2.89	19.91	.705
123	Oct. 1, 1909	1.0981	23.53	3.82	19.72	.748
149	Oct. 4, 1909	1.0943	22.43	2.78	19.66	.590
Norton:[2]						
102	Sept. 28, 1909	1.0965	22.90	4.83	18.09	1.984
124	Oct. 1, 1909	1.0997	23.60	4.97	18.63	1.705
150	Oct. 4, 1909	1.0945	22.46	4.37	18.10	1.589
5	Sept. 4, 1910	1.0477	11.78	4.98	6.79	2.927
15	Sept. 9, 1910	1.0617	15.07	4.33	10.73	2.373
29	Sept. 13, 1910	1.0687	16.68	3.70	12.89	2.000
49	Sept. 16, 1910	1.0775	18.66	3.46	15.20	2.067
62	Sept. 20, 1910	1.0933	22.20	4.78	17.43	1.837
85	Sept. 23, 1910	1.0943	22.43	4.52	17.92	1.605
133	Sept. 26, 1910	1.0927	22.07	3.19	18.88	1.493

[1] Grown by J. Schonhardt, at Venice, Ohio. [2] Grown by E. L. Steuk, at Venice, Ohio.

O